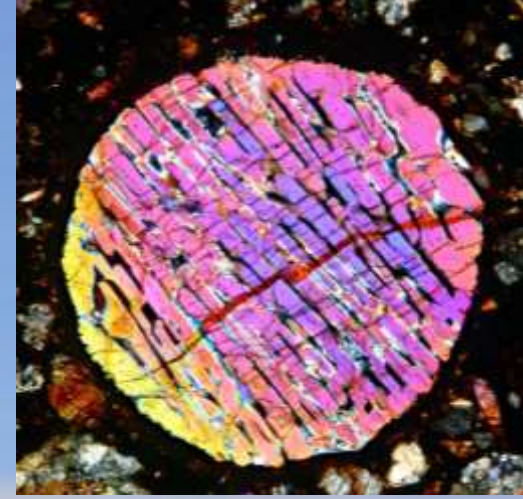


Geoscience Information for Teachers Workshop

# Meteorites in Antarctica:

*Why we collect space rocks in  
the coldest place on Earth*



Philip Janney, Associate Professor  
Department of Geological Sciences  
University of Cape Town

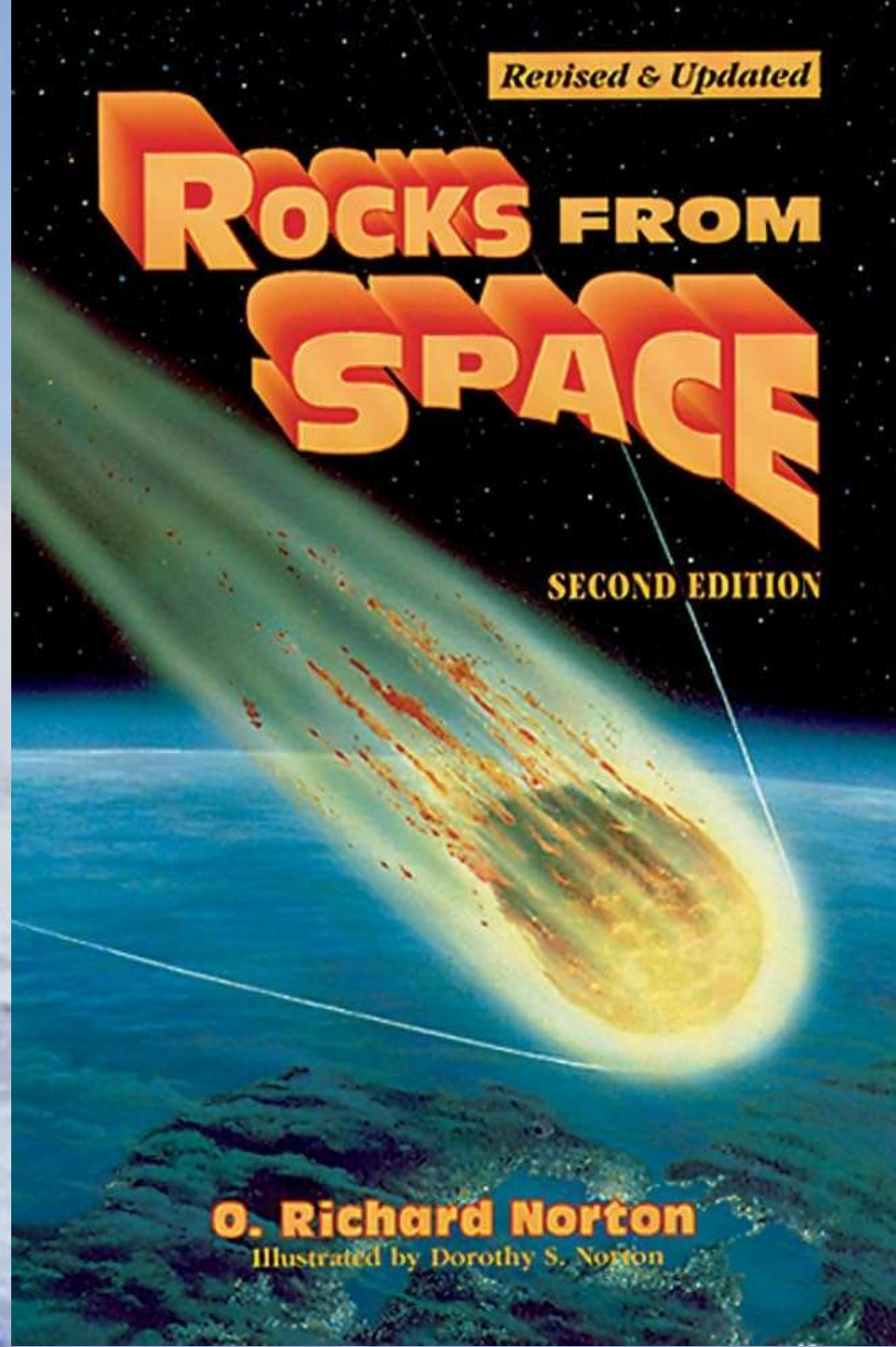


University of Cape Town  
iYunivesithi Yasekapa  
Universiteit van Kaapstad

- I. Meteorites: rocks from space and where they fall**
- II. What are meteorites and what do they tell us?**
- III. How and why do we look for meteorites in Antarctica**
- IV. Famous Antarctic meteorites & discovery of ET life?**



Meteorites are:



**O. Richard Norton**  
Illustrated by Dorothy S. Norton

# Typical rock in Cape Town



Probability of being a meteorite: less than 1 in 1 billion

# Rock-strewn field in Sahara desert



Probability of being a meteorite: at best, less than one in 1 million

The monetary value of meteorites is widely known (and often exaggerated).

Their scientific value (what they tell us about the origins of our planet, solar system and universe) is *incalculable*...



*Kolang carbonaceous chondrite (Indonesia), 2.2 kg*

They are an important economic resource for Tuareg people in northern Africa who collect them for sale to meteorite dealers



# Rock-strewn field in Antarctica



Probability of being a meteorite (in some cases) greater than 1 in 100



Most meteorites are leftovers from the formation of the Solar system

# TYPES OF SPACE ROCK



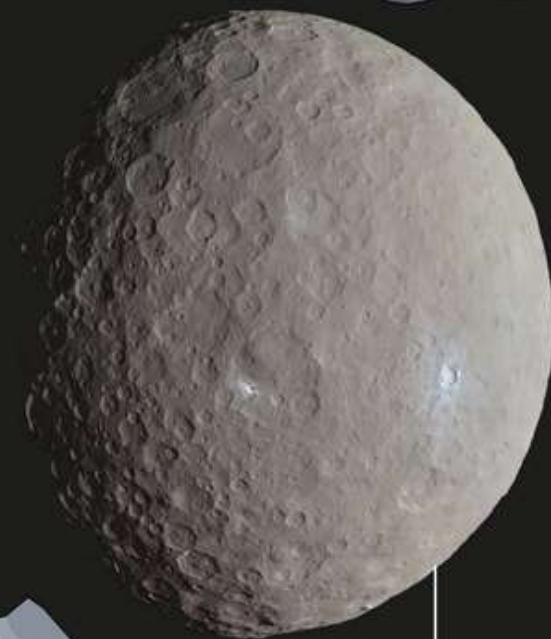
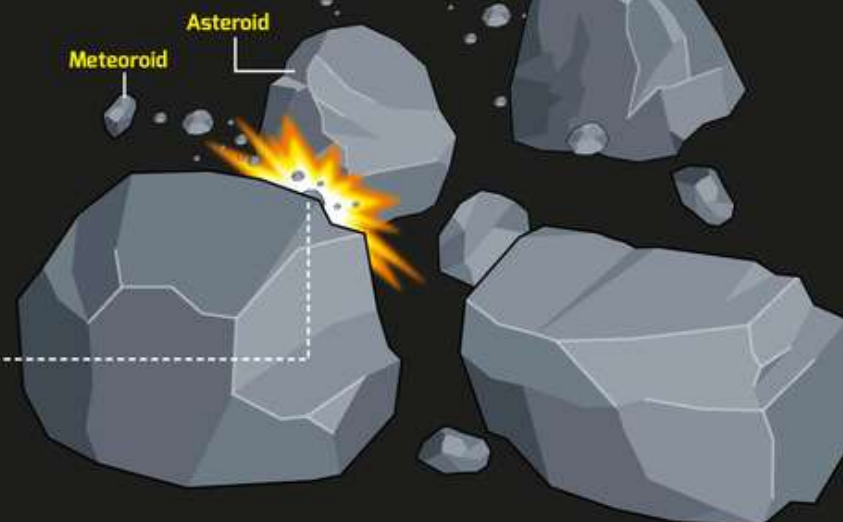
## ASTEROIDS

Asteroids are large chunks of rock, or metallic rock, left over from the formation of the Solar System. Asteroids range in size from as little as a metre to thousands of metres – the biggest are known as planetoids, or dwarf planets.



Most asteroids are located in the **Asteroid Belt** between Mars and Jupiter. It is thought that Jupiter's gravity prevented them from coming together to form a planet. There are also two groups of asteroids, called the **Trojans**, that live in the orbit of Jupiter. Asteroids can also be found way out beyond the orbit of Neptune in the Kuiper Belt.

Sometimes asteroids can be knocked free from the Asteroid Belt by collisions or from being disturbed by the gravity of larger objects, such as planets. In these collisions, small pieces of rock are also thrown out into space – this is where most meteoroids come from.



The largest asteroid in the Solar System is Ceres, which is 952 km wide and looks like a small moon. Ceres is classed as a dwarf planet.



## Comet

A chunk of ice, rock and dust, which develops a bright coma and tails when it is closer to the Sun  
(nucleus ~10km wide, coma 1000s of km wide, tails millions of km long)

## Micrometeoroid

A bit of rock or ice, from the size of a speck of dust to a grain of sand  
(10µm to 2mm wide)



## Meteoroid

A piece of rock, ice and/or metals, from space dust up to boulders in size  
(10µm to 1m wide)



## Asteroid

A large object in space, mainly composed of rock and metals, with some ice  
(1m to 100s of km wide)

## Fireball

A meteor that is at least as bright as Venus

## Meteorite

A meteoroid or asteroid that survives its trip to Earth's surface\*



## Bolide

An exceptionally bright fireball that ends with the meteoroid or asteroid exploding

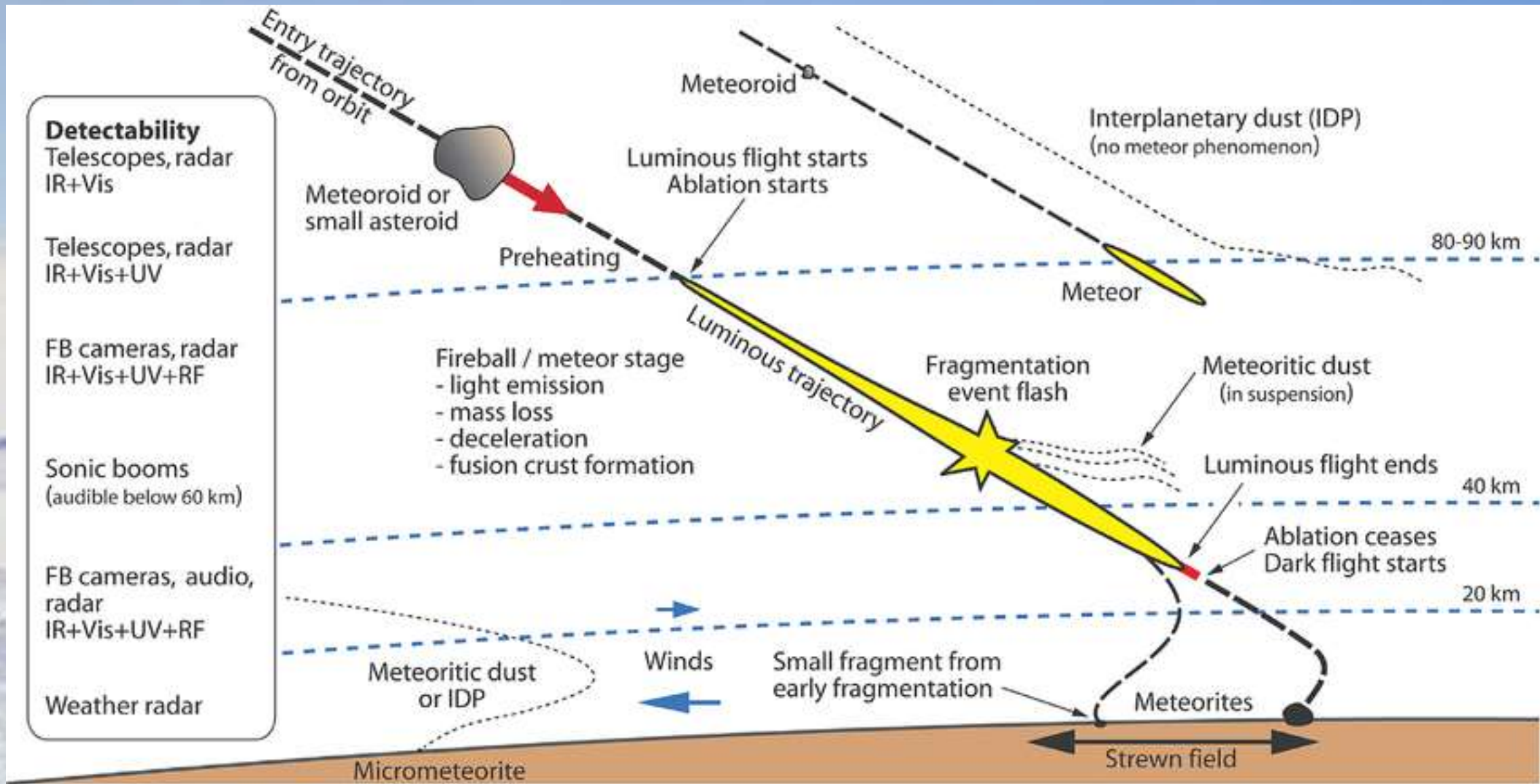


## Meteor

A streak of light in the sky, produced by a meteoroid entering the atmosphere, either on its own (sporadic) or as part of a meteor shower



\*Meteorite shown is NWA 1918-EUC, on



# Where do meteorites strike the Earth?

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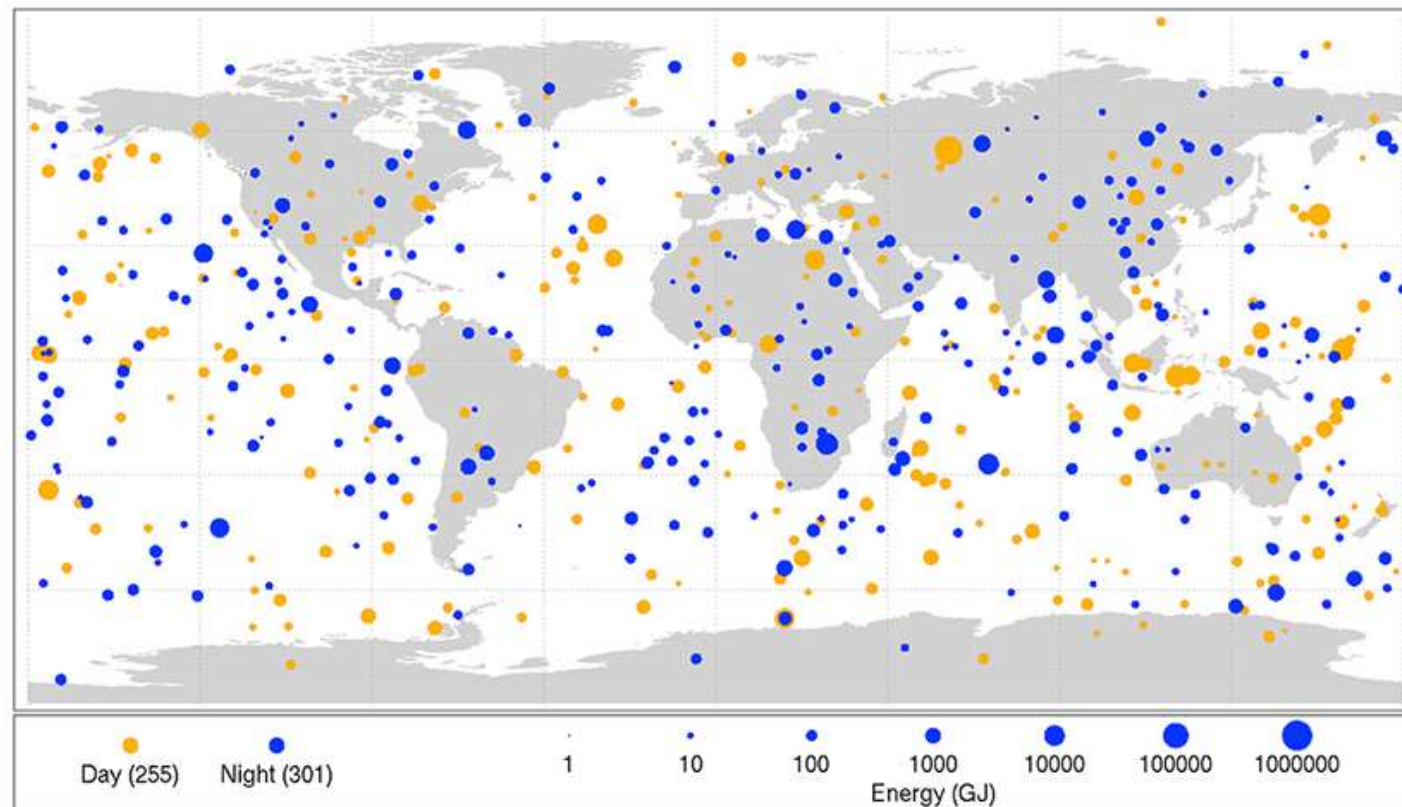
Falls occur randomly around the globe!

## Fireballs in the Sky: Bolides

Small asteroids frequently enter and disintegrate in Earth's atmosphere randomly around the globe, creating fireballs known as bolides. NASA's Near-Earth Object Program mapped data gathered by U.S. government sensors from 1994 to 2013.

### Bolide Events 1994–2013

(Small Asteroids that Disintegrated in Earth's Atmosphere)

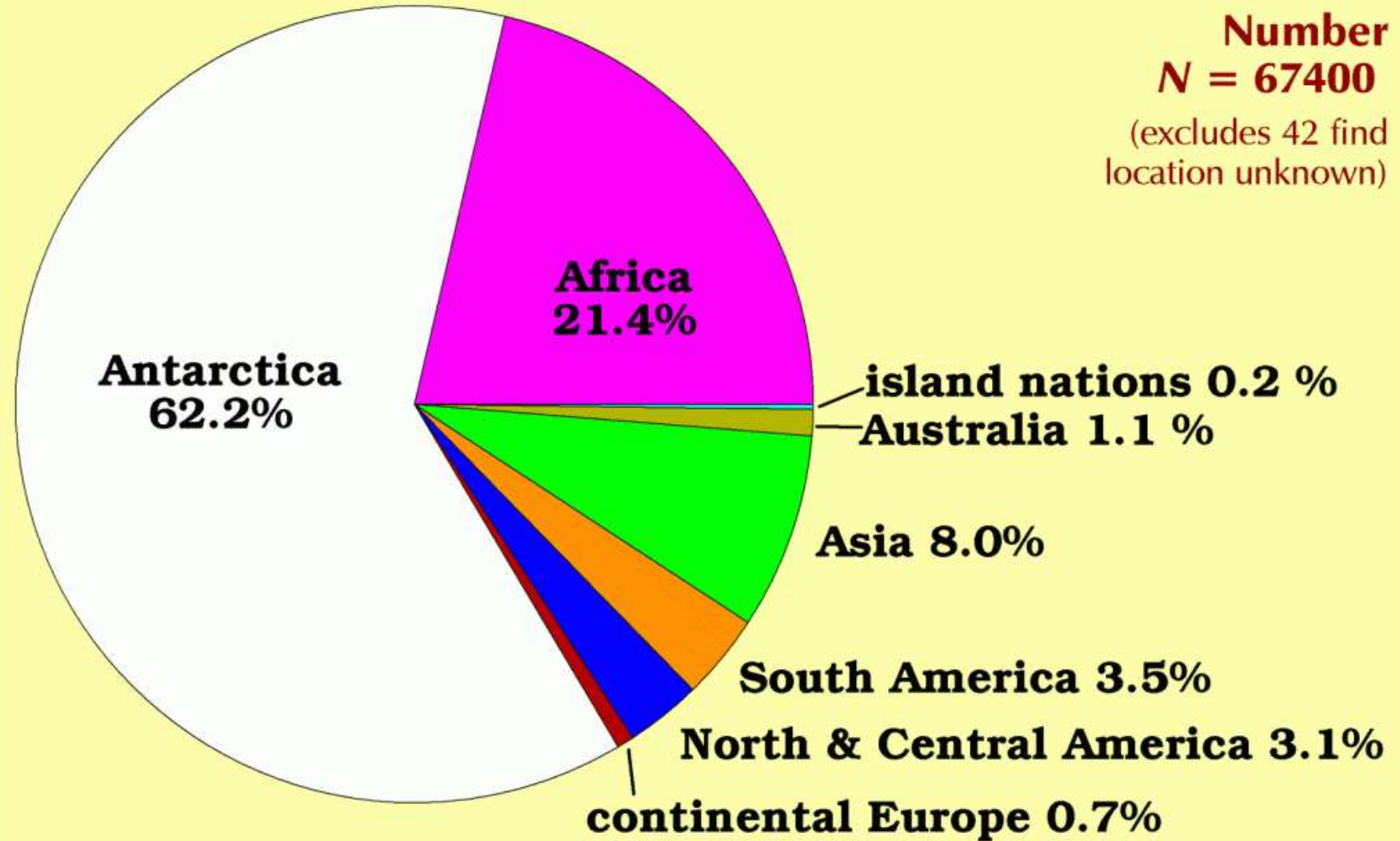


Source: NASA

Most meteorites are found in deserts (hot or cold)

## Where Are Meteorites Found? (by continent)

**Number**  
**N = 67400**  
(excludes 42 find location unknown)



Data from the Meteoritical Bulletin Database, December 14, 2021. Prepared by Randy L. Korotev

# How do we recognize meteorites?

- Fusion crust
- High density (specific gravity)
- Attracts a magnet
- Presence of metallic iron

*Not all meteorites will necessarily have all of these characteristics*



Meteorite (iron meteorite)



“Meteowrong” (slag from smelter)



**Fusion crust** – thin, dark, glassy coating caused by melting of outer surface due to friction with the atmosphere.



# Chondrites: the most common meteorite type

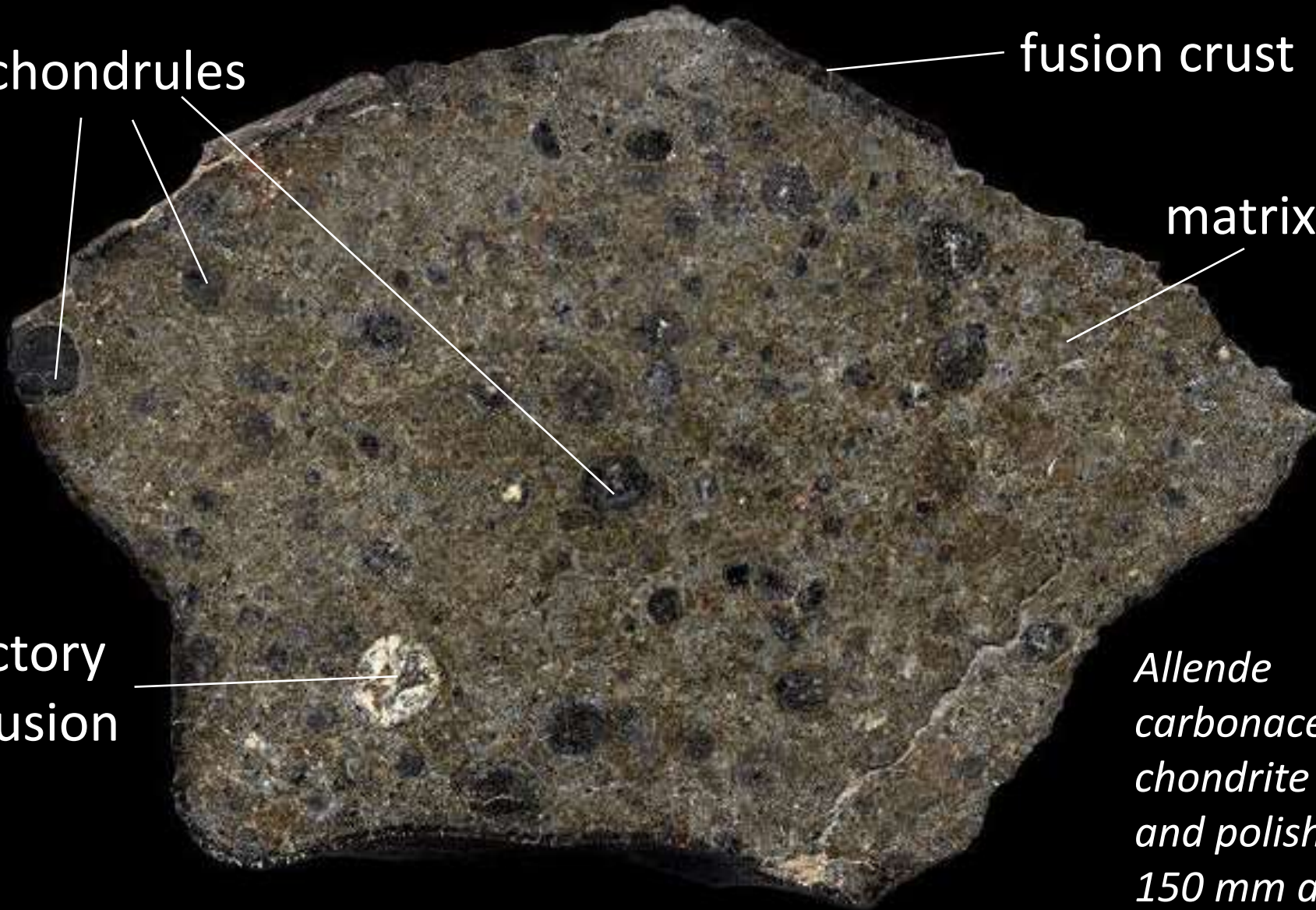
chondrules

fusion crust

matrix

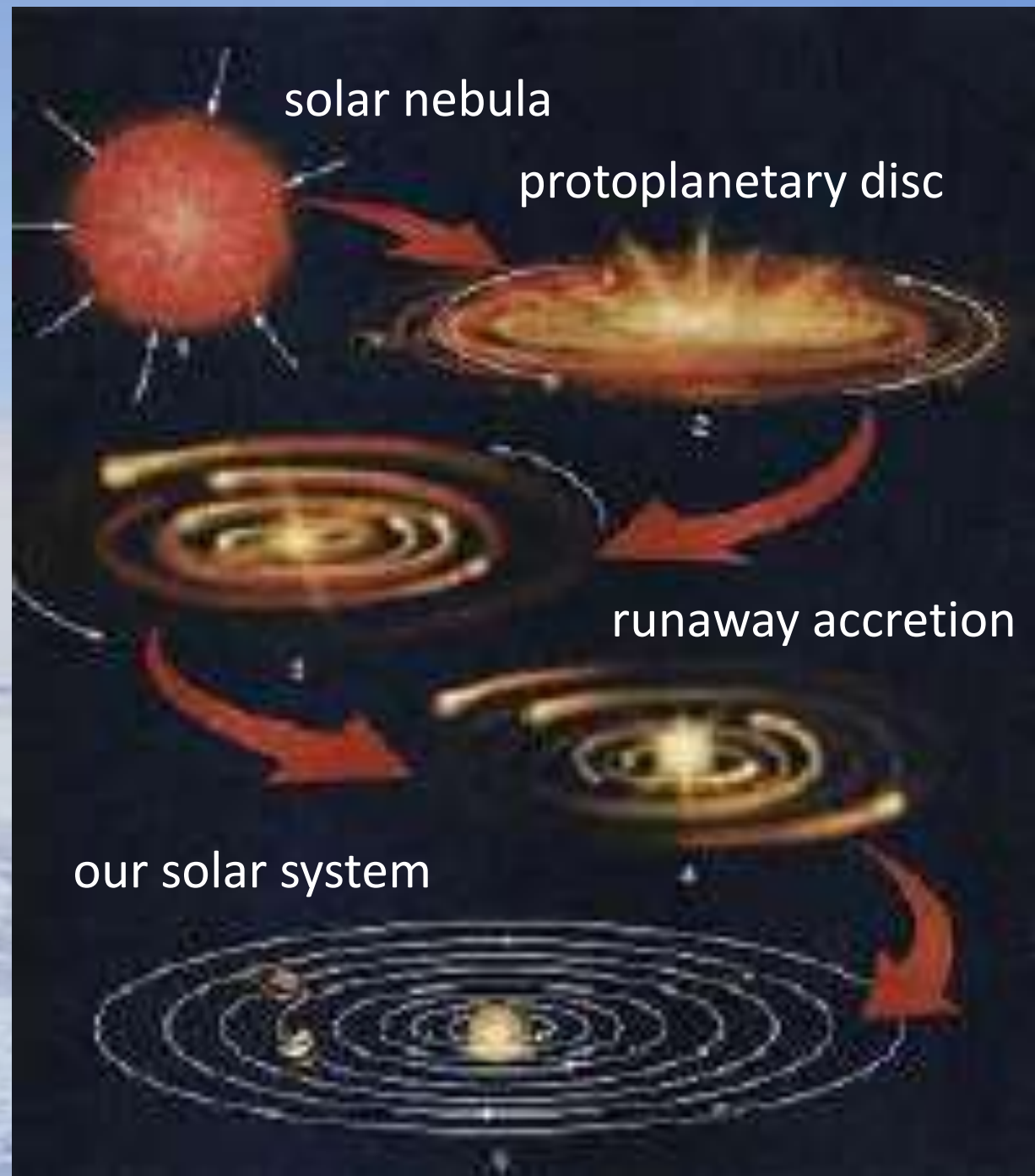
refractory  
inclusion

*Allende  
carbonaceous  
chondrite (cut  
and polished slab)  
150 mm across*





Meteorites preserve information about the timing and conditions of the formation & early development of the solar system and planetary bodies (i.e., planets, moons, dwarf planets, large asteroids)

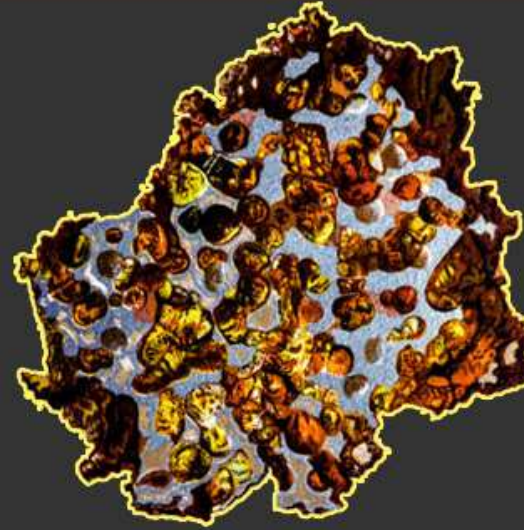


# TYPES OF METEORITES



## **Stony**

Stone-like, with small flecks of metal



## **Stony-Iron**

Smooth & glossy, embedded with silicates

## Achondrites

No chondrules on the surface



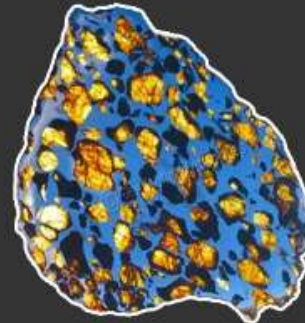
## Chondrites

Has Chondrules on the surface



## Pallasites

Solid bodies of iron-nickel, with greenish or olive crystals



## Mesosiderites

Debris of asteroid collisions, with small silicate crystals



# Iron

Has nickel, with Widmanstätten structure

## Hexahedrites

Low nickel content (>5.8%),  
no Widmanstätten  
structure



## Octahedrites

Low-average nickel  
content (5-10%),  
with Widmanstätten  
structure



## Ataxites

High nickel content (<18%),  
no Widmanstätten  
structure



*Widmanstätten  
pattern*



Facts.net

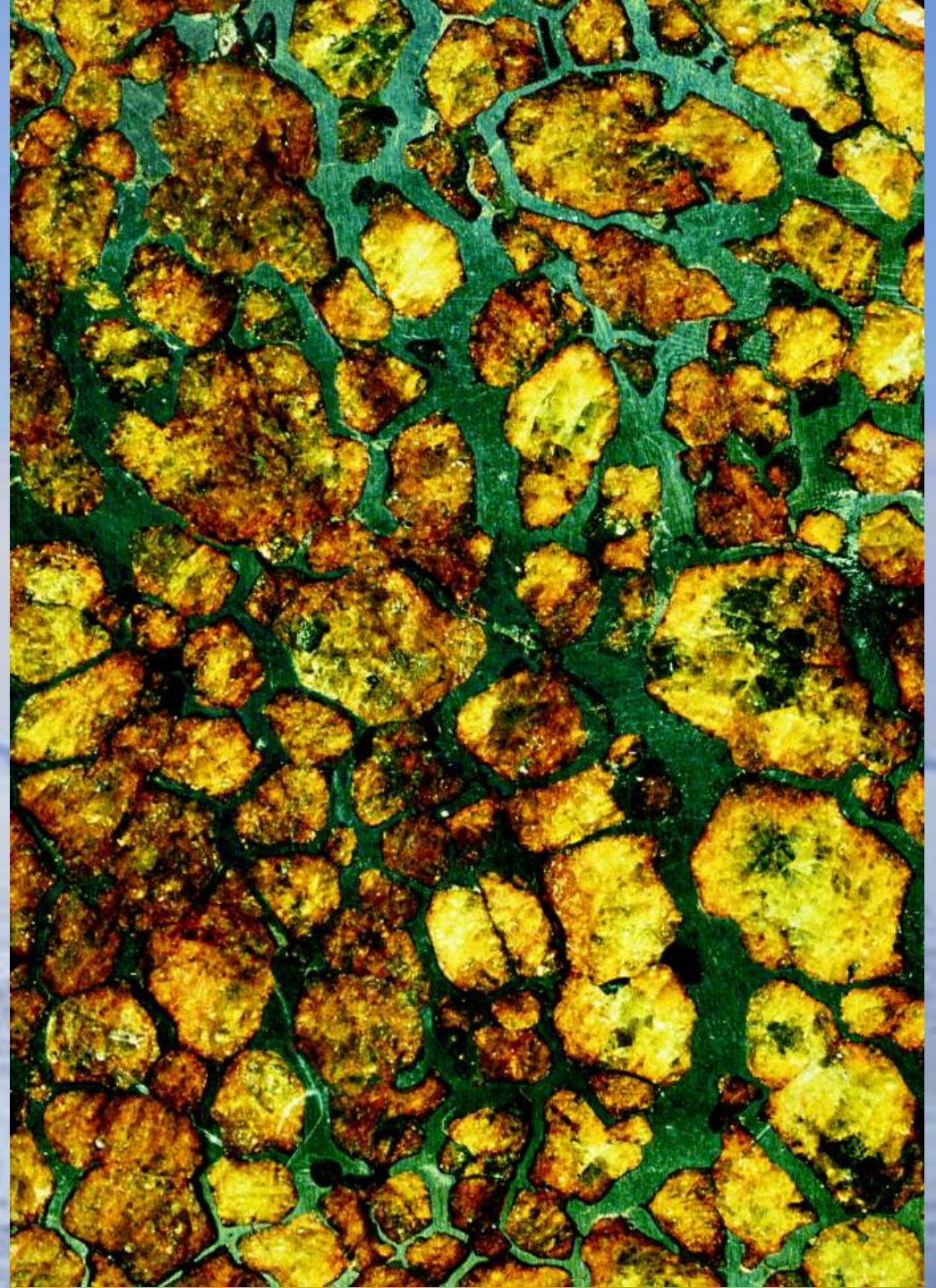
**Regmaglypts -**  
“thumbprint  
impressions”  
caused by  
differential  
ablation of Fe-Ni  
metal, sulphide  
minerals and  
graphite



**Terrestrial alteration** is the replacement of original minerals with new minerals formed in equilibrium with environmental conditions (presence of water and oxygen)

Even though alteration is minimal in desert environments, it does occur in hot deserts (e.g., the Sahara desert, northern Africa).

*Olivine-rich achondrite meteorite  
(from North Africa)  
largely altered to serpentine*



# Why go to Antarctica to collect meteorites?

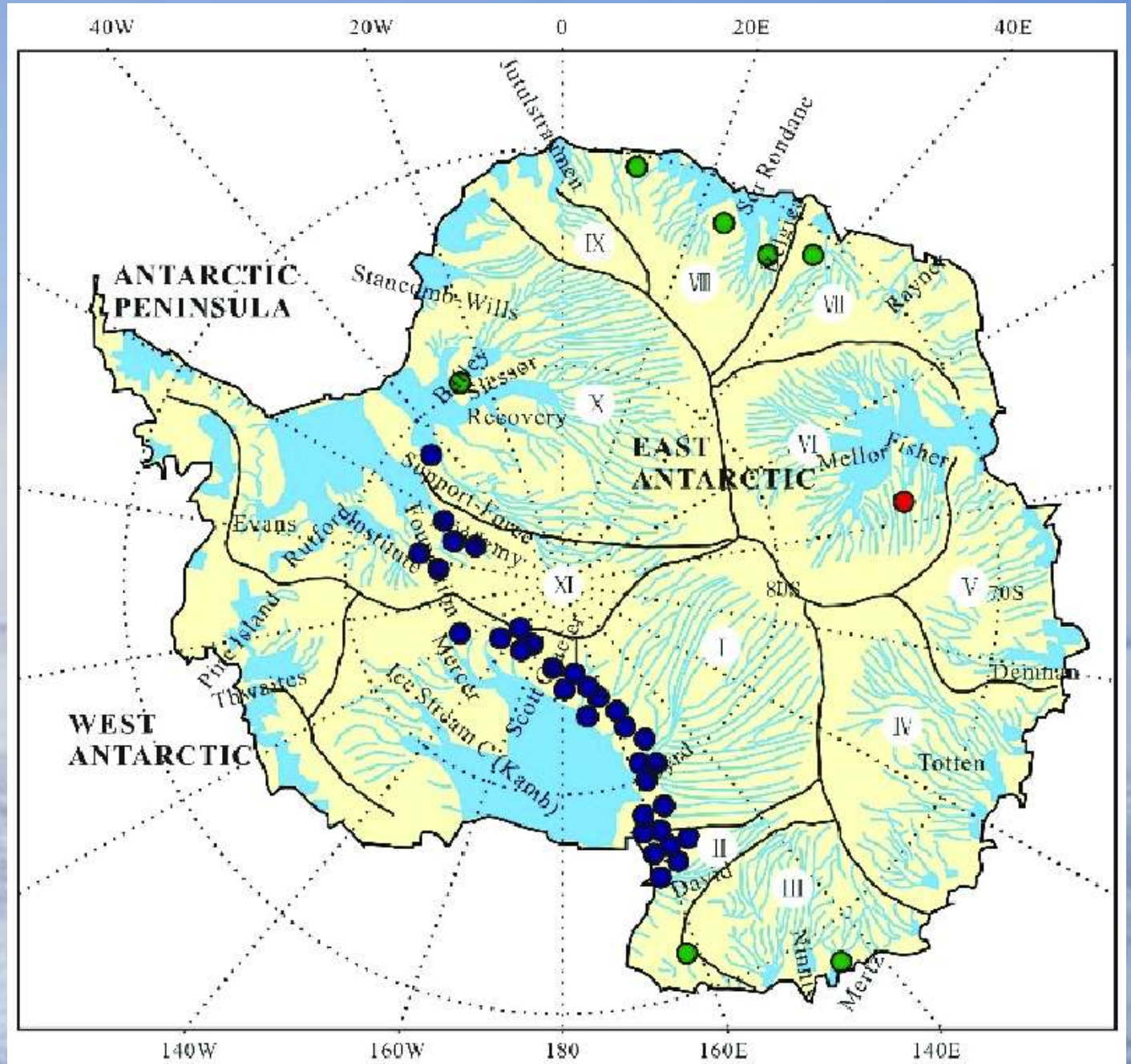
- Abundance & ease of discovery
- Cold dry environment means minimal terrestrial alteration
- Preserves organic matter and other sensitive material



# Where do we find Antarctic meteorites?

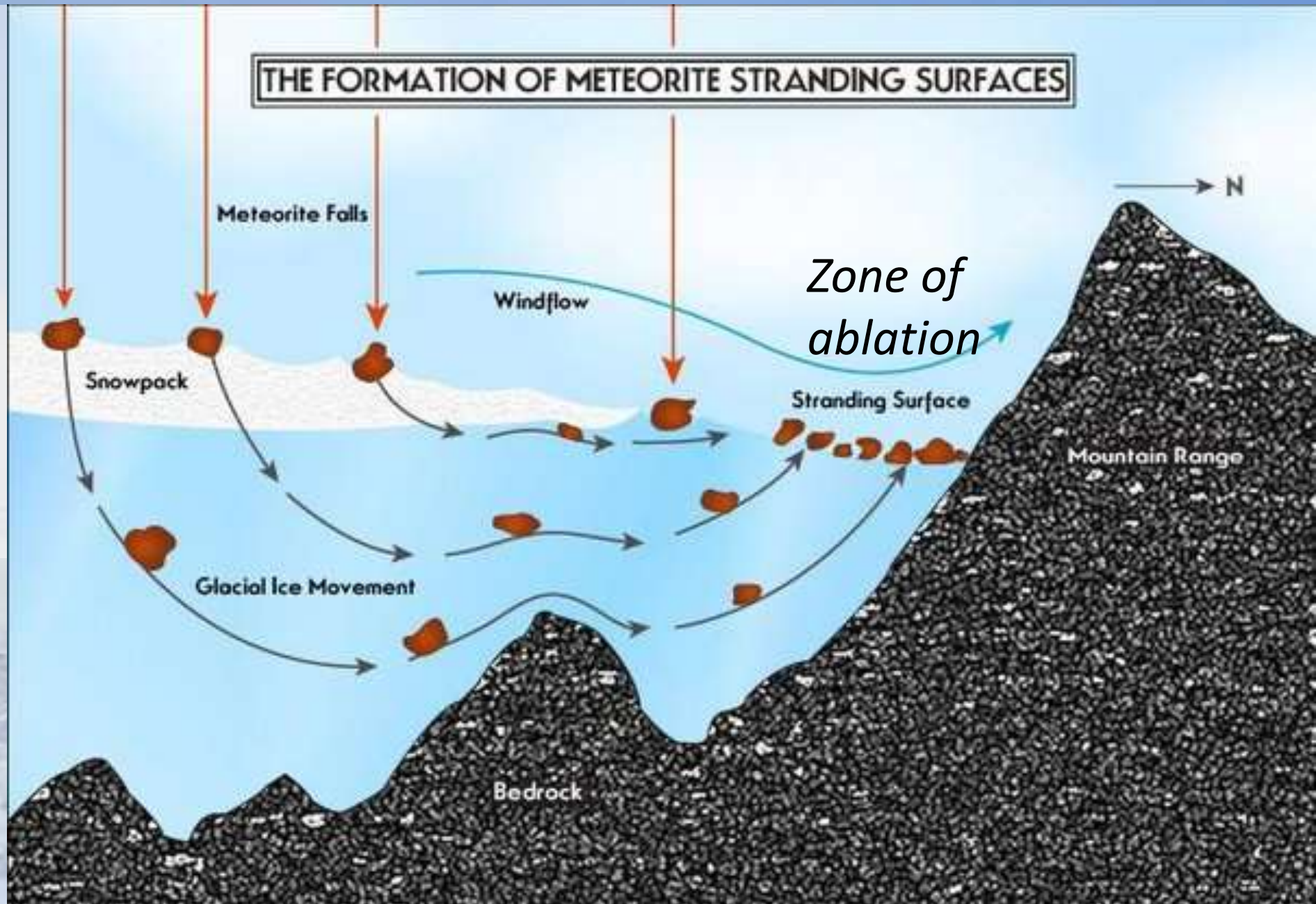
Not everywhere...

Found especially in ice  
fields adjacent to the  
Trans-Antarctic  
Mountains (blue circles)



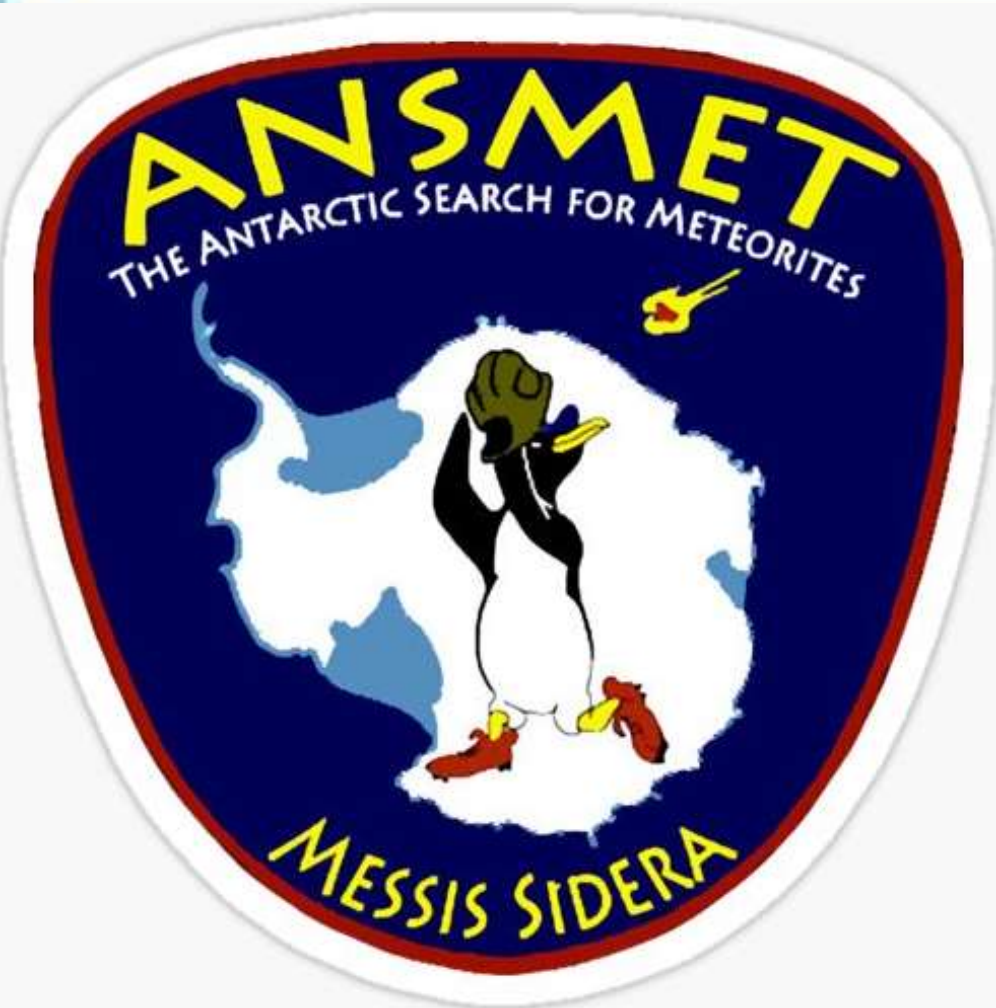
# Why?

Glacial ice sheet movement concentrates meteorites in ice fields adjacent to mountains





# The USA (and Japan) run national programs to collect Antarctic meteorites



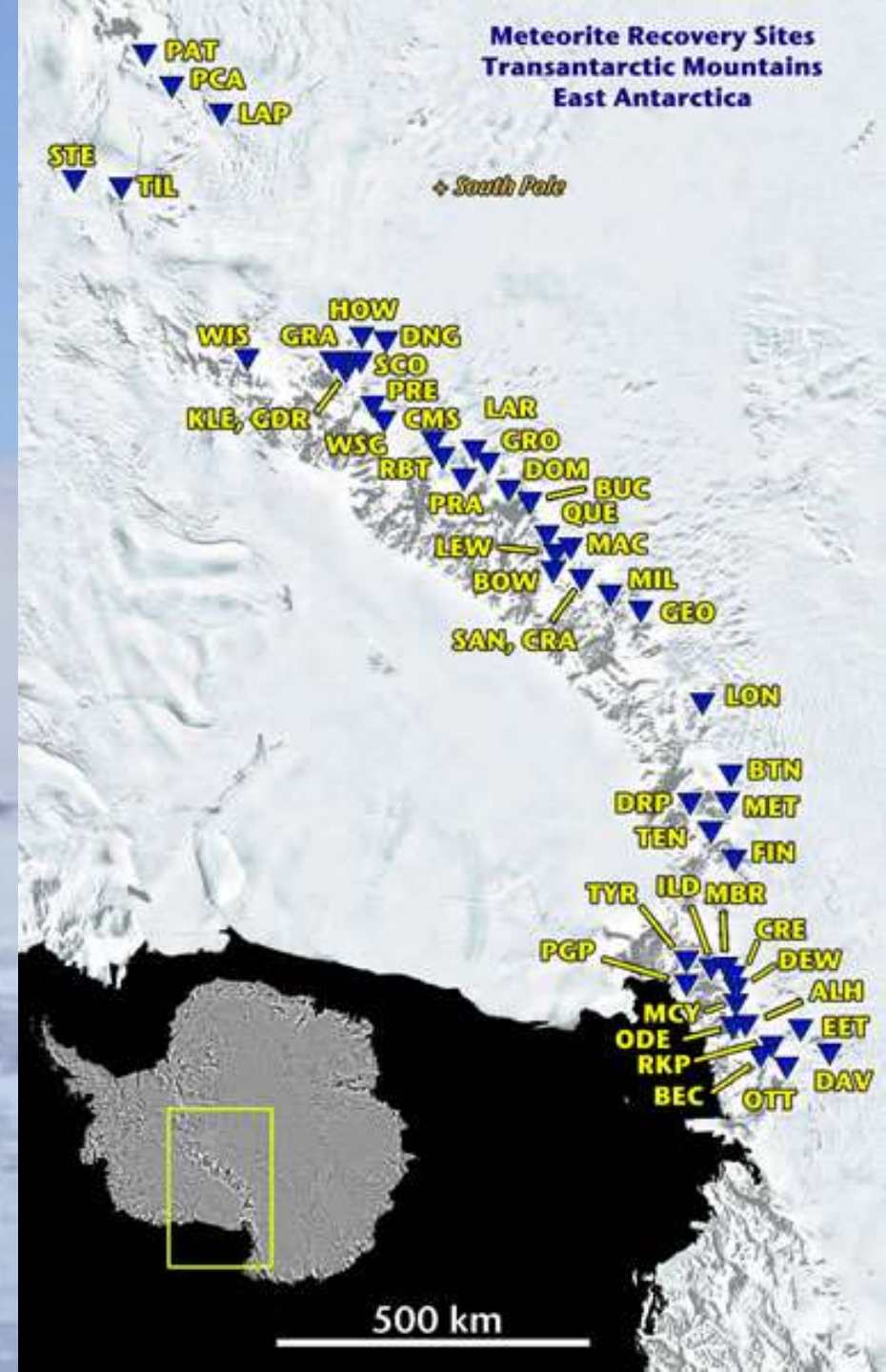
# The USA (and Japan) run national programs to collect Antarctic meteorites



# Where do we find Antarctic meteorites?

Not everywhere...

Found especially in ice fields adjacent to the Trans-Antarctic Mountains (blue triangles)



# “Famous” Antarctic meteorites

LAP 02205 Iron-rich  
basalt, La Paz  
Icefield

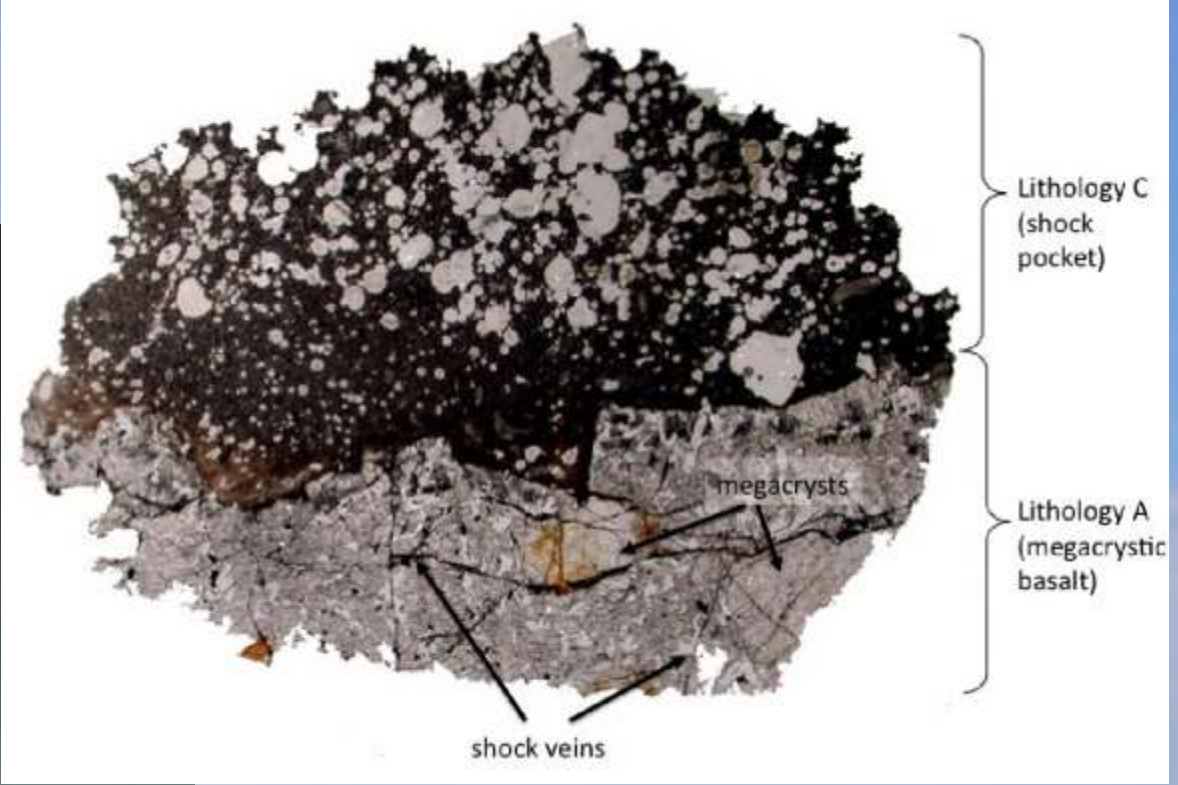


QUE 93069  
Feldspar-rich  
breccia, Queen  
Alexandra Range



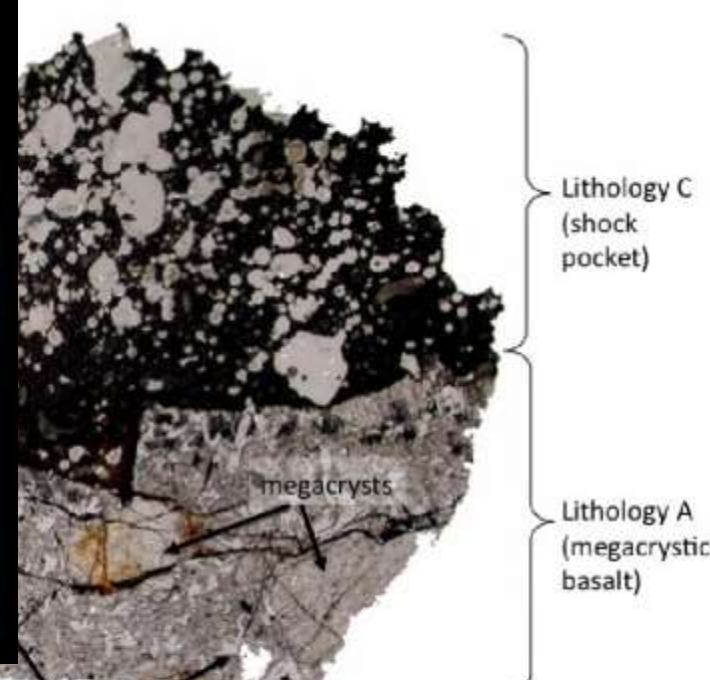
Lunar  
meteorites  
(from Earth's moon)

EETA79001 Shergottite (Martian meteorite),  
Elephant Moraine



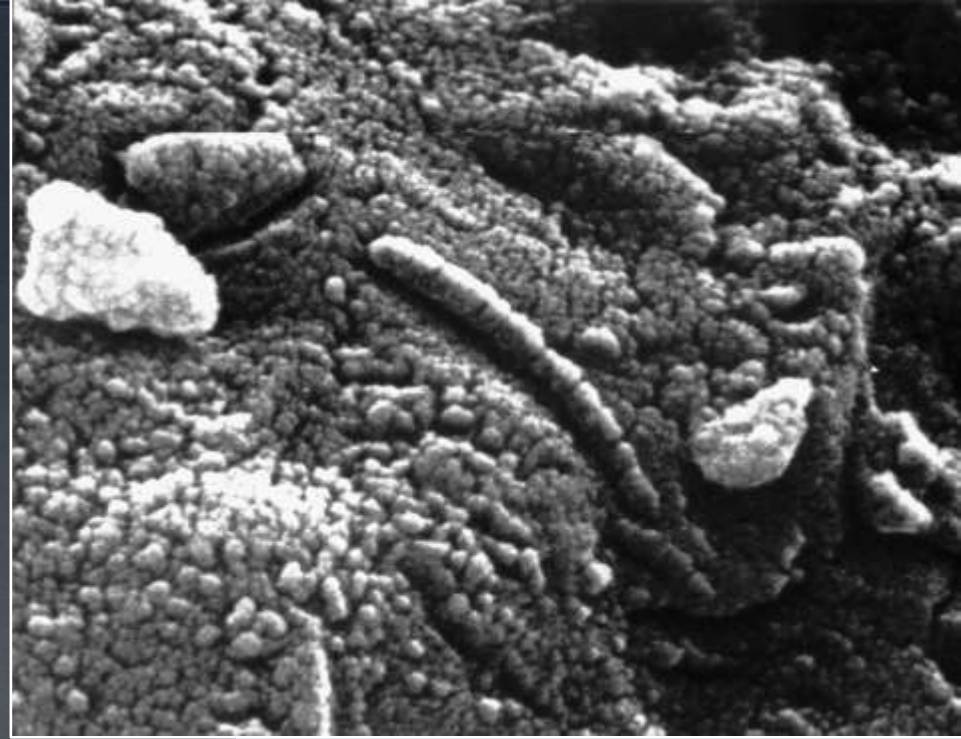
*Shergottites* are a type of basalt (lava or shallow intrusion of basaltic magma) found on Mars

# EETA79001 Shergottite (Marti Elephant Moraine)



EETA790

ALH84001,0



### **ALH84001**

Martian meteorite (pyroxenite) with bacteria-like structures in cracks and veins found in Alan Hills, Antarctica.

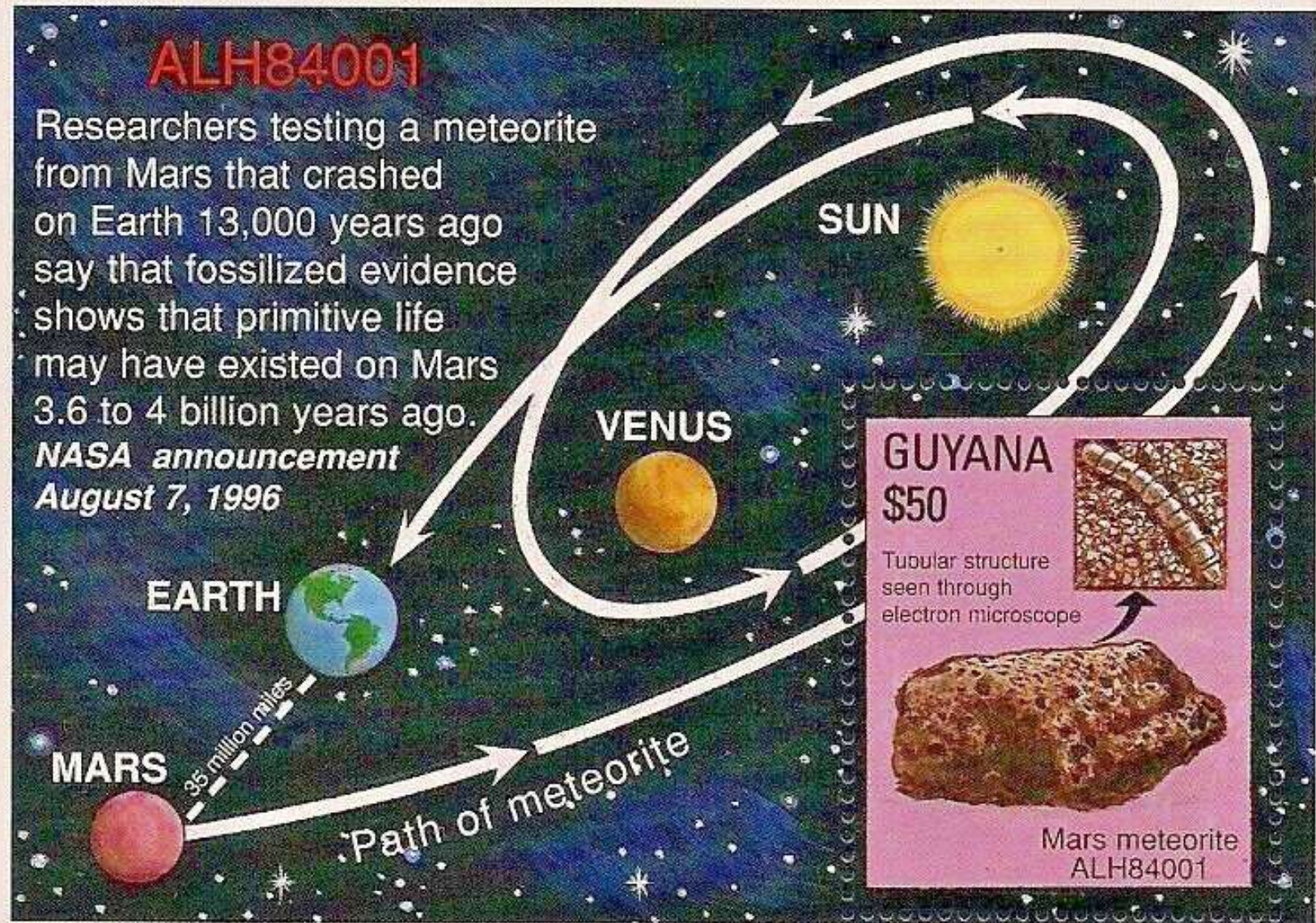
Massive public interest at time of publication (*Science*, 1996)

- ALH84001 is definitely from Mars
- Bacteria-like structures are not derived from Earth
- These structures are now wholly mineral, but could possibly represent fossils of ancient bacterial life on Mars.
- Age of ALH001 is >4 billion years, bacteria-like features almost certainly are much younger.

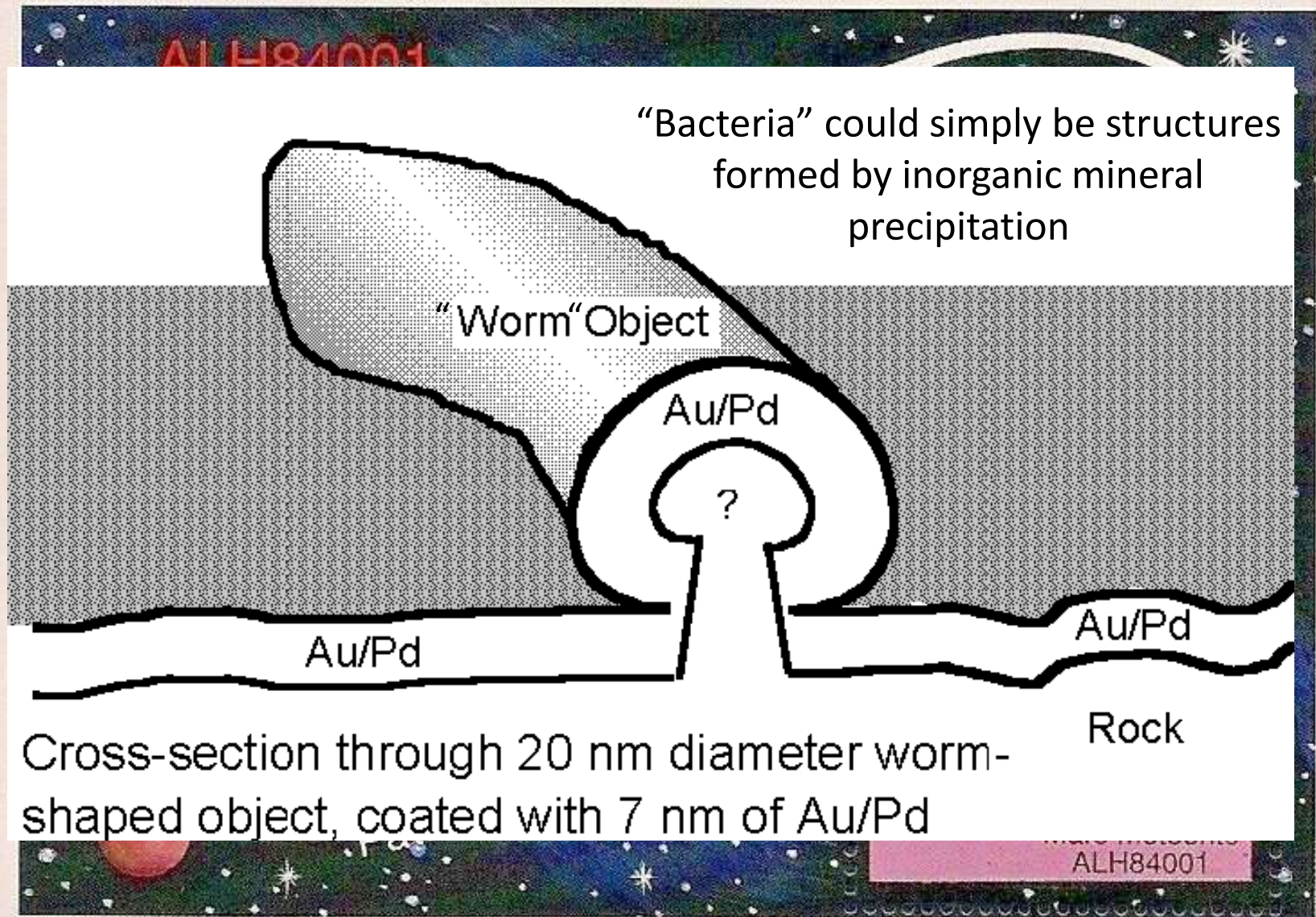
The screenshot shows the Sun newspaper website. At the top, there are navigation links for 'HOME', 'MY SUN', 'SUN LITE', 'SITE MAP', 'NEWS ALERTS', and 'SUNTALK'. A search bar is also present. The main headline is 'Life from Mars' in large, bold letters. Below the headline is a large image showing a rock on the left and a close-up of a human eye on the right. The text below the image reads 'Rock of ages ... part of meteorite that hit Antarctica and graphic of Mars craters'. The article is by Paul Sutherland, 'Sun Spaceman', and was published today. There are 8 comments. Below the article is a 'RELATED STORIES' section with a link to 'Fly me to the moon... again'. On the right side of the page, there is a 'Sun BINGO!' advertisement featuring a pirate character and the text 'PLAY FROM 1p'. The left sidebar contains various news categories like 'NEWS', 'VIDEO', 'SPORT', 'SHOWBIZ', 'TV', 'LIVE it WOMAN', and 'FUN & GAMES'.



Nearly 30 years after discovery in 1996, there remains no consensus on whether the structures found in ALH 84001 represent fossil bacteria (life) or not.






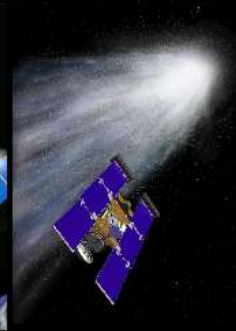



















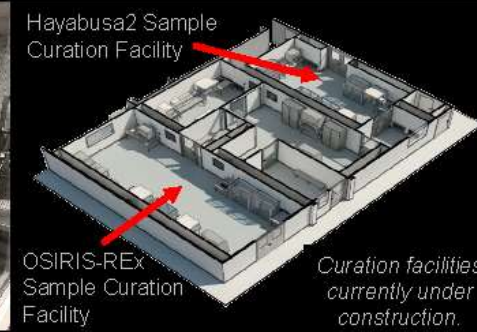
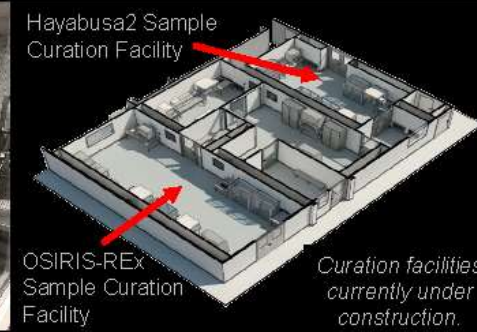


Nearly 30 years after discovery in 1996, there is no consensus on whether the structures found in ALH 84001 actually represent fossil bacteria (life) or are rather inorganic mineral structures that just look like it.



# NASA'S ASTROMATERIALS COLLECTIONS

housed at the NASA Johnson Space Center in Houston, TX

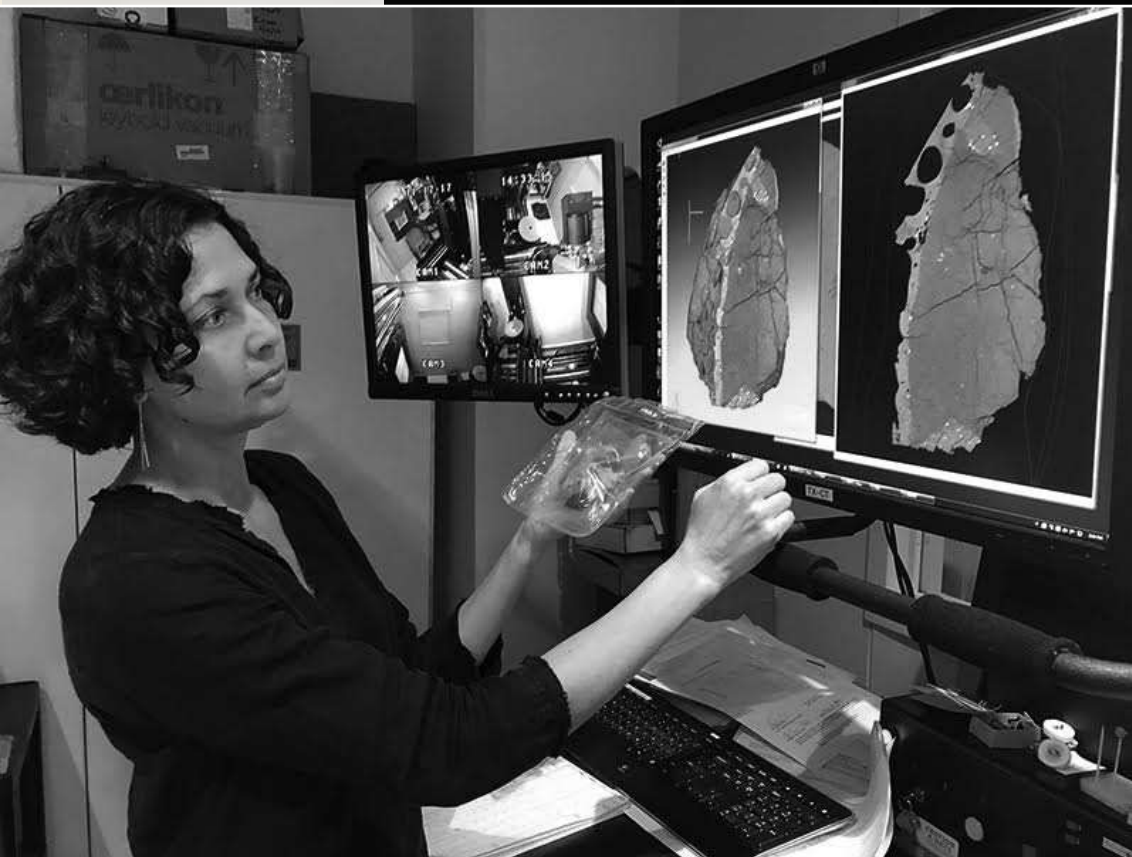
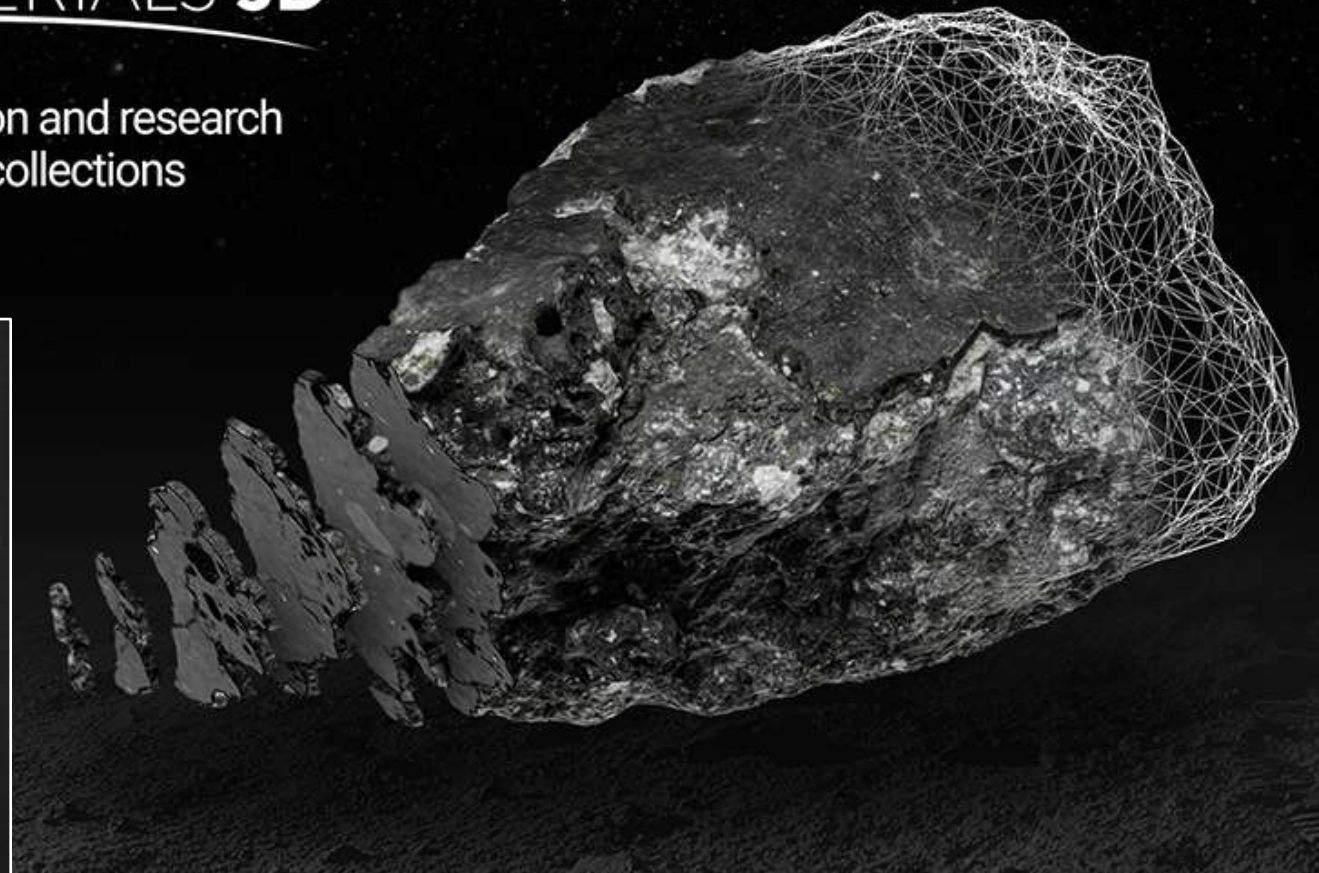
1969	1978	1981	1985	2004	2006	2010	2020	2023
<b>LUNAR</b>	<b>ANTARCTIC METEORITES</b>	<b>STRATOSPHERIC COSMIC DUST</b>	<b>MICROPARTICLE IMPACTS</b>	<b>GENESIS</b>	<b>STARDUST</b>	<b>HAYABUSA</b>	<b>HAYABUSA2</b>	<b>OSIRIS-REx</b>
								
								
382 kg (842 lbs) of lunar material collected by Apollo astronauts	>22,000 meteorites from asteroids, the Moon, & Mars	>1000 particles collected from comets and asteroids	~12 spacecraft components impacted by interplanetary dust & space debris	Solar wind atoms collected in wafers at Earth-Sun L1 point	Cometary (Wild 2) & interstellar dust collected in aerogel	Subset of loose material (regolith) collected from Asteroid Itokawa	Subset of loose material (regolith) from Asteroid Ryugu	>60g (0.13 lbs) of loose material (regolith) from Asteroid Bennu
								



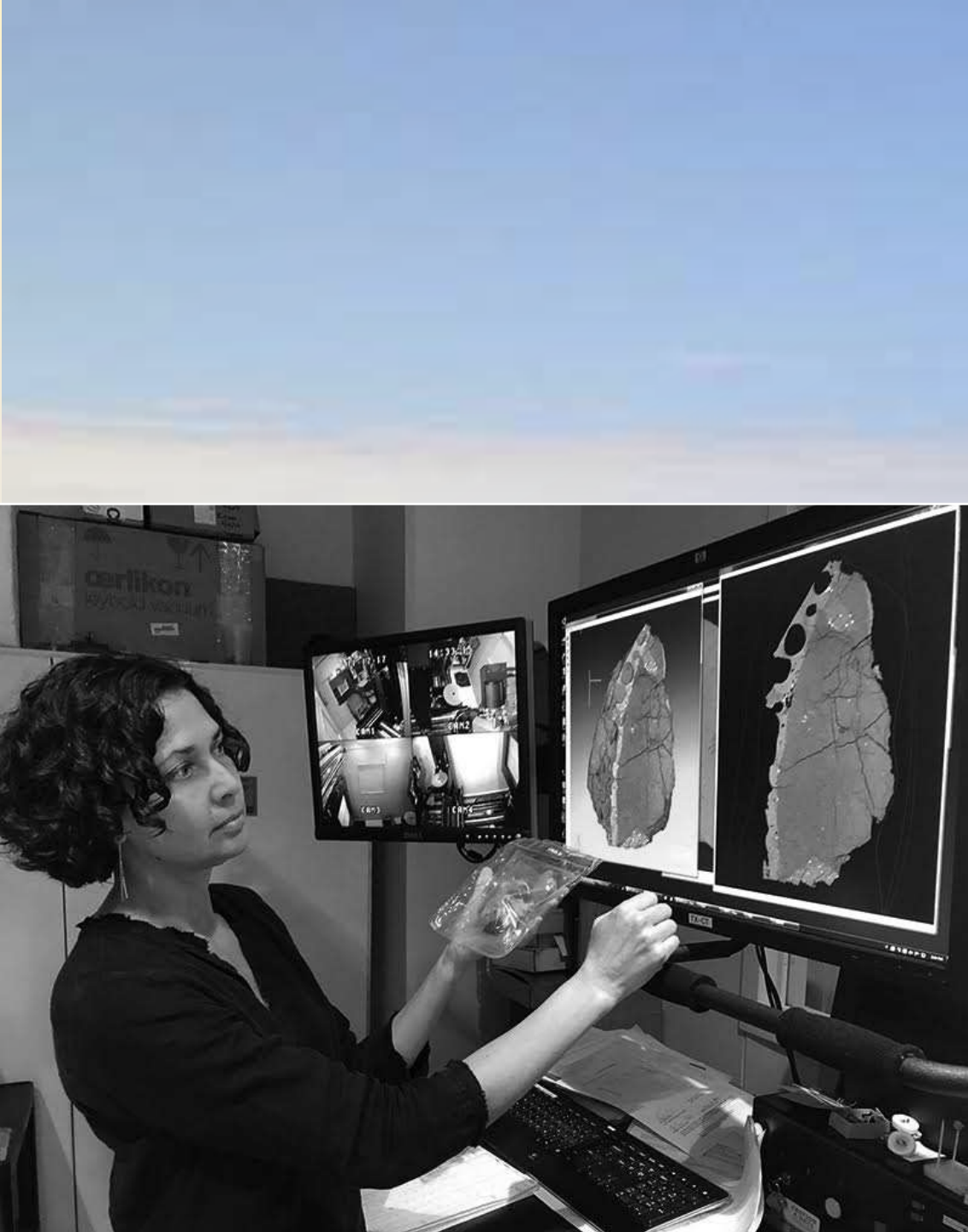


# ASTROMATERIALS 3D

A virtual library for exploration and research  
of NASA's space rock collections



*Collections staff digitizing meteorite collection*



 **ASTROMATERIALS 3D**

**ANNOUNCING NEW SELECTIONS  
OF APOLLO LUNAR  
AND ANTARCTIC METEORITE SAMPLES  
AVAILABLE NOW**

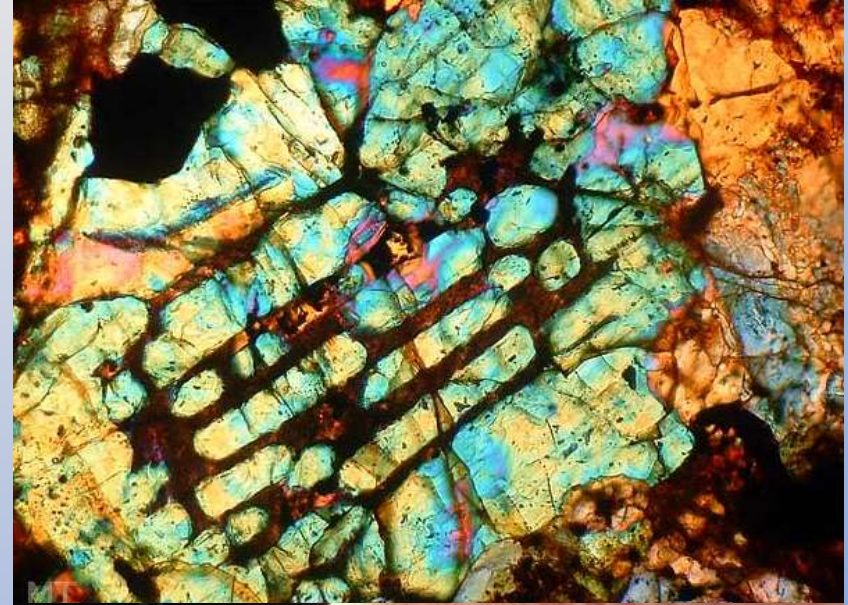
[HTTPS://ARES.JSC.NASA.GOV/ASTROMATERIALS3D](https://ares.jsc.nasa.gov/astromaterials3d)

*Collections staff digitizing meteorite collection*



## Education

Research &  
Understanding  
our place in the  
Universe



Geoheritage &  
Tourism

*Meteorites are  
more than just  
space rocks*

